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SHORT REPORT

Comparison of Antero-posterior and Transverse Aortic Diameters: Implications for Routine Aneurysm Surveillance

R. J. Holdsworth* and C. Shearer

Department of Vascular Surgery, Stirling Royal Infirmary, Livilands, Stirling FK8 2AU, Scotland, UK

Introduction

The current management of abdominal aortic aneurysms has been determined by the UK small aneurysm trial.¹ This study reported that surgical treatment of aneurysms ≤ 5.5 cm in diameter conferred no survival benefits and the risk of rupture was $<1\%$ per annum for aneurysms smaller than this size. On the basis of these results it has become customary to monitor aneurysms smaller than 5.5 cm by regular ultrasound surveillance and consider surgery only when they reach this size.

The aortic measurement used for the UK small aneurysm study was the anterior–posterior (AP) diameter. This dimension was selected on the basis of a small pilot study showing the AP diameter was more reproducible than the transverse diameter between scans and gave a better correlation to the diameter measured on CT scan.²

A number of years ago, we started routinely reporting both AP and transverse diameters of our aneurysms. In this study, we compare the results of these measurements and introduce the concept of the ‘mean cross-sectional area’ as a basis for aneurysm measurement.

Methods

Patients with aortic aneurysms were identified from a computerised registry which detailed demographic

data and all ultrasound measurements including repeat surveillance scans.

Only those aneurysms with simultaneous AP and transverse diameter measurement were included. Aortic measurements with both diameters <3.0 cm and those measured only by CT were excluded. In instances when patients had multiple measurements as part of our surveillance program only the most recent measurement was used.

We assessed two methods for calculating an approximate mean cross-sectional area (Fig. 1). Both of these were based on using the formula for calculating the area of a perfect disc (πr^2). Both methods are therefore based on finding a value for the radius. In method 1, the mean radius was calculated by taking the sum of both diameters, dividing by 4 and squaring the result. In method 2, each diameter was halved and the values multiplied. We decided to use method 2 for the purpose of this study because for more elliptical aneurysms it calculated a slightly lower area (Fig. 1). In practice the difference calculated was marginal being only 0.2 cm^2 for a diameter difference of 1 cm. Examples of differences in calculated area between these two methods are shown in Fig. 1.

Results

A total of 185 aneurysms were identified for this study of which 128 (69%) were in men. The distribution of aneurysms based on the largest diameter is illustrated in Table 1. Two-thirds of the aneurysms (65%) were <5.5 cm in maximum diameter and 37 (20%) had both diameters ≥ 5.5 cm. The remaining 27 (15%) had one diameter ≥ 5.5 cm and the other < 5.5 cm.

Ninety-four aneurysms had <3 mm difference in

*Corresponding author: R. J. Holdsworth, Department of Vascular Surgery, Stirling Royal Infirmary, Livilands, Stirling FK8 2AU, Scotland, UK.

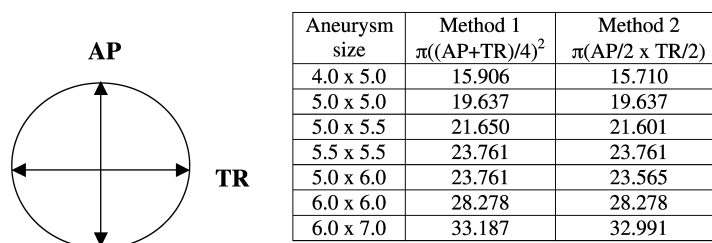


Fig. 1. Illustration of the method of calculating mean cross-sectional area by two methods based on different aneurysm sizes.

their dimensions. Of the remainder, 77 had a greater transverse diameter and only 14 had a greater AP diameter. Forty-five (24%) had a transverse diameter that exceeded the $AP \geq 0.5$ cm and only 11 (6%) had a greater AP diameter of ≥ 0.5 cm. Of the 27 aneurysms with one diameter ≥ 5.5 cm and the other < 5.5 cm, 17 had a greater transverse diameter. Thus, 17 patients may not have been offered surgery if the criteria of the UK small aneurysm trial were rigidly applied.

Being conscious of this discrepancy in measurement of aneurysms with an elliptical cross-section, we explored the relationship of the diameters with the calculated area.

A 5.5×5.5 cm aneurysm would have a calculated cross-sectional area of 23.67 cm^2 . Of those aneurysms with both diameters ≥ 5.5 cm, the smallest calculated area was 24.19 cm^2 . The most difficult management decisions will occur when one diameter is ≥ 5.5 cm and the other is < 5.5 cm. Of the 17 aneurysms with a greater transverse diameter, the smallest calculated area was 22.06 cm^2 and in the 10 with a greater AP diameter the smallest area was 20.43 cm^2 . We found a further nine aneurysms in our series with both diameters < 5.5 but an area of greater than 20 cm^2 and all had at least one diameter > 5.1 cm.

A more detailed breakdown of the aneurysms based on calculated areas between 20 and 29 cm^2 is in Table 2. Above a cross-sectional area of 23 cm^2 , all aneurysms had at least one diameter greater than 5.5 cm. Interestingly, we found 12 aneurysms with an AP diameter < 5.5 and area $> 23 \text{ cm}^2$.

Discussion

The assessment of aortic aneurysm size based on a single diameter measurements is inherently inaccurate and this study has shown that at least one third of aneurysms have an elliptical cross-section to the extent that there is > 0.5 cm difference in the two diameters. The true relationship between size and risk of rupture is not known and it is almost certainly a multi-factorial problem.^{3,4} Probably the ideal measurement for assessing aneurysms would be based on volume scanning. However, this would require the use of spiral CT scanning, which for many hospitals may be impractical and would also expose the patients to repeated doses of radiation. For practical reasons alone we need a relatively simple method of assessment that is easily understood, validated and repeatable.⁵ Although the measurement techniques in this paper have not been validated internally, all scans were undertaken by trained sonographers and variation in measurements is therefore likely to be within clinically acceptable variation. We feel that this reflects 'actual' practice in many institutions and that it is important to report variations in measurements that occur in routine clinical practice.

The relatively poor correlation previously reported between CT and ultrasound for measurement of the transverse diameter² may be explained by the fact that aneurysms are frequently associated with elongation of the vessel. A CT scan will transect the aneurysm in the transverse plane of the body rather than

Table 1. Distribution of the size of aneurysms based on the maximum diameter. The totals have been broken down to the component parts to demonstrate which is the greatest measurement.

Maximum diameter (cm)	Total (<i>n</i>)	Greater AP diameter					Greater transverse diameter			
		≥ 10 mm	5–9 mm	3–4 mm	<3 mm	Equal	<3 mm	3–4 mm	5–9 mm	≥ 10 mm
<4.0	55	0	2	0	5	15	16	10	7	0
4.0–4.9	45	0	0	1	4	8	13	8	7	4
5.0–5.4	21	0	0	0	4	4	4	4	4	1
5.5–5.9	24	1	2	2	5	2	4	4	4	0
6.0–6.4	17	2	0	0	1	5	0	3	3	3
6.5–6.9	13	1	2	0	1	1	0	3	2	3
>7.0	10	0	1	0	1	1	0	0	2	5
Totals	185	4	7	3	21	36	37	32	29	16

Table 2. Distribution of aneurysms by calculated mean cross-sectional area between 20 and 29 cm².

Calculated area (cm ²)	Total (n)	Number with either diameter 5.5–5.9 cm	Number with either diameter ≥6.0 cm	Number with only AP ≥5.5 cm	Number with only Transverse ≥5.5 cm	Number with both ≥5.5 cm
20–20.99	7	2	0	2	0	0
21–21.99	4	0	1	1	0	0
22–22.99	8	6	0	1	5	0
23–23.99	8	7	1	4	4	0
24–24.99	8	6	2	1	3	4
25–25.99	6	2	3	1	3	2
26–26.99	4	3	4	0	2	2
27–27.99	2	0	2	0	0	2
28–28.99	4	0	4	0	0	4

perpendicularly to the aneurysm giving an apparent larger diameter.⁵ In addition, because aneurysms are associated with elongation, the lumbar vertebrae will prohibit posterior expansion and elongation is therefore more likely to occur laterally.

We have found the concept of using a calculated mean cross-sectional area as a convenient way of eliminating the problem of the discrepancy in aneurysm diameter. Although we accept that this is, at best, an approximation of the true cross-sectional area, we believe that it offers a better assessment than a single AP or transverse measurement.

The use of mean cross-sectional area calculation also allows us to study asymmetric growth of the aneurysm. Thus, if expansion occurs in one dimension followed, a year later, by expansion in the other dimension, we have the ability to analyse the change in mean cross-sectional area with time.

The majority of institutions probably use routine ultrasound surveillance for their aortic aneurysms. It could be argued that measurement of cross-sectional area may add to the complexity of scanning. In practice we have found that this additional measurement is rapid, does not slow down scan time and standardises routine aneurysm assessment in clinical practice. We would suggest that routine reports on aortic aneurysms should contain details of at least two measurements undertaken at right angle planes.

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